REMARKS

The specification has been amended to correct the typographical error noted by the examiner on page 85.

Claims 1-21 were present in the application as filed. Claim 1 has been amended, and claims 13-18 have been canceled without prejudice in response to a restriction requirement. Claims 20 and 21 have also been canceled. Claims 1-12 and 19 are pending in the application.

Claims 1-5, 10-11 and 19-21 were rejected under 35 U.S.C. 112, second paragraph, as indefinite. The Examiner wished a clarification of the significance of "*n*" appearing after "(C_1-C_6)". The term "*n*" is employed in the claims in its conventional sense. It would be understood by the person of ordinary skill in the art to describe straight chain alkanes. That this usage is conventional and needs no further definition is supported by a copy of pages 83-85 of Organic Chemistry, Fourth Edition by L. G. Wade, Jr., Prentice Hall, 1999, a standard textbook in the field. Reconsideration and withdrawal of the rejection are respectfully requested.

Claims 20 and 21 were rejected under 35 U.S.C. 112, first paragraph as lacking enablement. Claims 20 and 21 have been cancelled.

Claims 1-12 and 19-21 were rejected as being drawn to an improper Markush group. The Examiner indicated that deletion of the nonelected subject matter would overcome this rejection. Applicants have amended claim 1 so that it is restricted to the elected invention. Claims 13-18, which related to unelected inventions have also been cancelled. The rejection is therefore believed overcome.

Finally, the Examiner inquired whether the proviso in the definition of X, Y and Z was necessitated by prior art. Applicant's undersigned representative, who did not

draft the application, has been informed by an inventor that to the best of his knowledge the proviso was introduced to reflect the correlation between structure and utility of the claimed compounds (SAR) and not as a result of prior art.

There being no further outstanding issues, the Application is believed in condition for allowance.

October 25, 2004

Respectfully submitted,

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FOURTH EDITION

Organic Chemistry

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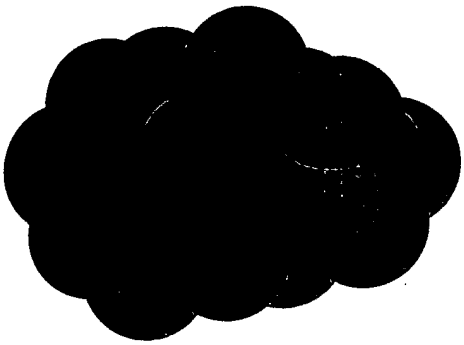


CHAPTER 3

Structure and Stereochemistry of Alkanes

Whenever possible, we will study organic chemistry using families of compounds to organize the material. The properties and reactions of the compounds in a family are similar, just as their structures are similar. By considering how the structural features of a class of compounds determine their properties, we can predict the properties and reactions of similar new compounds. This organization elevates organic chemistry from a catalog of many individual compounds to a systematic study of a few types of compounds. Organic molecules are classified according to their reactive parts, called *functional groups.* We considered some of the common functional groups in Sections 2-14 through 2-16.

An **alkane** is a hydrocarbon that contains only single bonds. The alkanes are the simplest and least reactive class of organic compounds because they contain only carbon and hydrogen and they have no reactive functional groups. Although alkanes undergo reactions such as cracking and combustion at high temperatures, they are much less reactive under most conditions than other classes of compounds having functional groups.

3-1 Classification of Hydrocarbons (Review)

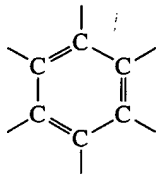
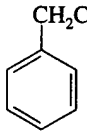
Hydrocarbons are classified according to their bonding (Section 2-14). A hydrocarbon with a carbon–carbon double bond (such as ethylene) is called an *alkene.* If a hydrocarbon has a carbon–carbon triple bond (like acetylene), it is called an *alkyne.* Hydrocarbons with aromatic (benzenelike) rings are called *aromatic hydrocarbons.* If a hydrocarbon has no double or triple bonds, it is said to be **saturated,** because it has the maximum number of bonded hydrogens. Another way to describe *alkanes,* then, is as the class of **saturated hydrocarbons.** The table at the top of the following page reviews the classification of hydrocarbons.

3-2 Molecular Formulas of Alkanes

The structures and formulas of the first 20 unbranched alkanes are shown in Table 3-1. Any isomers of these compounds have the same molecular formulas even though their structures are different. Notice how the molecular formulas increase by two hydrogen atoms each time a carbon atom is added.

The structures of the alkanes in Table 3-1 are purposely written in an unusual manner. The general formula for the unbranched (straight-chain) alkanes is a chain of $—CH_2—$ groups **(methylene groups),** terminated at each end by a hydrogen

Summary of Hydrocarbon Classification

Compound Type	*Functional Group*	*Example*
alkanes	none (no double or triple bonds)	$CH_3—CH_2—CH_3$, propane
alkenes	$>C=C<$ double bond	$CH_2=CH—CH_3$, propene
alkynes	$—C\equiv C—$ triple bond	$H—C\equiv C—CH_3$, propyne
aromatics	benzene ring 	 ethylbenzene

atom. These alkanes differ only by the number of methylene groups in the chain. If the molecule contains n carbon atoms, it must contain $(2n + 2)$ hydrogen atoms. Figure 3-1 shows this representation of alkane structure and how it leads to formulas of the form C_nH_{2n+2}.

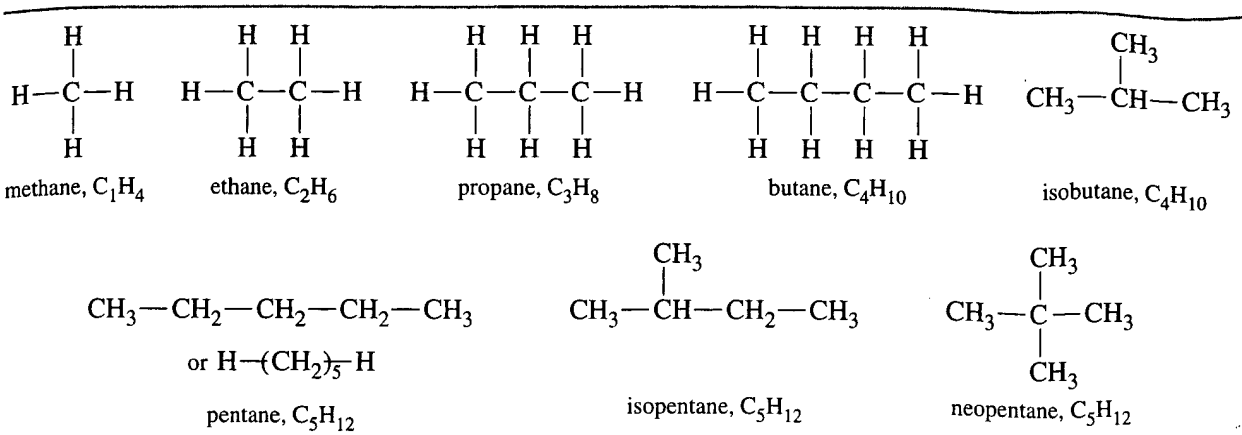
A series of compounds, like the n-alkanes, that differ only by the number of $—CH_2—$ groups, is called a **homologous series,** and the individual members of the series are called **homologs.** For example, butane is a homolog of propane, and both of these are homologs of hexane and decane.

Although we have derived the C_nH_{2n+2} formula using the n-alkanes, its use is not limited to unbranched molecules. Any isomer of one of these n-alkanes has

TABLE 3-1 Formulas and Physical Properties of the Unbranched Alkanes, Called the *n*-Alkanes

Alkane	*Number of Carbons*	*Structure*	*Formula*	*Boiling Point (°C)*	*Melting Point (°C)*	*Density*[a]
methane	1	$H—CH_2—H$	CH_4	−164	−183	0.55
ethane	2	$H—(CH_2)_2—H$	C_2H_6	−89	−183	0.51
propane	3	$H—(CH_2)_3—H$	C_3H_8	−42	−189	0.50
butane	4	$H—(CH_2)_4—H$	C_4H_{10}	0	−138	0.58
pentane	5	$H—(CH_2)_5—H$	C_5H_{12}	36	−130	0.63
hexane	6	$H—(CH_2)_6—H$	C_6H_{14}	69	−95	0.66
heptane	7	$H—(CH_2)_7—H$	C_7H_{16}	98	−91	0.68
octane	8	$H—(CH_2)_8—H$	C_8H_{18}	126	−57	0.70
nonane	9	$H—(CH_2)_9—H$	C_9H_{20}	151	−51	0.72
decane	10	$H—(CH_2)_{10}—H$	$C_{10}H_{22}$	174	−30	0.73
undecane	11	$H—(CH_2)_{11}—H$	$C_{11}H_{24}$	196	−26	0.74
dodecane	12	$H—(CH_2)_{12}—H$	$C_{12}H_{26}$	216	−10	0.75
tridecane	13	$H—(CH_2)_{13}—H$	$C_{13}H_{28}$	235	−5	0.76
tetradecane	14	$H—(CH_2)_{14}—H$	$C_{14}H_{30}$	254	6	0.76
pentadecane	15	$H—(CH_2)_{15}—H$	$C_{15}H_{32}$	271	10	0.77
hexadecane	16	$H—(CH_2)_{16}—H$	$C_{16}H_{34}$	287	18	0.77
heptadecane	17	$H—(CH_2)_{17}—H$	$C_{17}H_{36}$	303	23	0.76
octadecane	18	$H—(CH_2)_{18}—H$	$C_{18}H_{38}$	317	28	0.76
nonadecane	19	$H—(CH_2)_{19}—H$	$C_{19}H_{40}$	330	32	0.78
eicosane	20	$H—(CH_2)_{20}—H$	$C_{20}H_{42}$	343	37	0.79
triacontane	30	$H—(CH_2)_{30}—H$	$C_{30}H_{62}$	>450	66	0.81

[a] Densities are given in g/mL at 20°C, except for methane and ethane, whose densities are given at their boiling points.



▲ **Figure 3-1**
Examples of the general alkane molecular formula, C_nH_{2n+2}.

the same molecular formula. Butane and pentane follow the C_nH_{2n+2} rule; therefore, branched alkanes such as isobutane, isopentane, and neopentane also follow the rule.

PROBLEM 3-1

Using the general molecular formula for alkanes,

(a) Predict the molecular formula of triacontane, the C_{30} straight-chain alkane.
(b) Predict the molecular formula of 4,6-diethyl-12-(3,5-dimethyloctyl)triacontane, an alkane containing 44 carbon atoms.

3-3 Nomenclature of Alkanes

The names *methane, ethane, propane,* and *butane* have historical roots. From pentane on, alkanes are named using the Greek word for the number of carbon atoms, plus the suffix **-ane** to identify the molecule as an alkane. Table 3-1 gives the names and physical properties of the *n*-alkanes up to 20 carbon atoms.

3-3A Common Names

If all alkanes had unbranched (straight-chain) structures, their nomenclature would be very simple. Most alkanes have structural isomers, however, and we need a way of naming all the different isomers. For example, there are two isomers of formula C_4H_{10}. The unbranched isomer is simply called *butane* (or *n-butane,* meaning "normal" butane), and the branched isomer is called *isobutane,* meaning an "isomer of butane."